STRATEGY RESEARCH PROJECT

NATIONAL SECURITY IMPLICATIONS OF THE COMMERCIALIZATION OF SPACE

BY

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ABSTRACT

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Space is one of our nation's vital national interests. During the Cold War, space products and services were dedicated predominately for national security purposes with relatively little commercial utility, with the exception of communications. Within the past decade, space products and services have transitioned more and more into the commercial sector, realizing global commercial revenues approaching $65 billion in 1998. As this nation explores and exploits the importance of commercial space activities, it must weigh the costs, benefits, and vulnerabilities between "enhancing our security" and bolstering our "economic prosperity." Striking a balance between these two core national security objectives is critical to our nation's future and essential to providing sound leadership to this nation's space program and more importantly, the international space community.

This paper discusses current national space strategy, law, and policies - focusing predominately on commercial space, explores the four economically prosperous commercial space activities - communications, remote sensing, navigation, and launch - as well as the implications each of these activities has on our future national security, and concludes with recommendations on how this nation can best posture its space program to gain maximum economic benefit while preserving national security.

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NATIONAL SECURITY IMPLICATIONS OF THE COMMERCIALIZATION OF SPACE

The time has come to address, among Warfighters and national policy makers, the emergence of space as a center of gravity for DoD and the nation.[1]

—General Howell M. Estes, III
CINCUSSPACECOM

Space is one of our nation's vital national interests.[2] During the Cold War, space products and services were dedicated predominately for national security purposes with relatively little commercial utility, with the exception of communications. With the end of the Cold War and the break-up of the Soviet Union, U.S. policy towards space gradually changed making space a profitable endeavor for the commercial industry. Space products and services transitioned more and more into the commercial sector, realizing global commercial revenues approaching $65 billion in 1998, versus global government revenues of approximately $35 billion.[3] The U.S. government lifted restrictions on a number of previously hard to access Department of Defense (DoD) activities and information, to include numerous military and intelligence space activities[4] and countless information pertaining to satellite manufacturing and space technology. A number of nations and corporations very quickly began inculcating their national resources into the economically profitable world of space. The primary space activities providing the greatest commercial opportunities were communications, remote sensing, navigation, and launch.

A number of countries and commercial enterprises have invested heavily in space-based communications, remote sensing, navigation, and launch assets within the past ten years. There is every indication that this trend will continue in the future.

> "Over the next decade, the average annual rate of satellite launches could more than double, with 1,500 to 1,800 satellites being lofted into space. The growing output of space-related companies is equally dramatic.... The space industry currently accounts for more than 960,000 jobs worldwide and is expanding at a rate of 40,000 jobs a year. During the past five years, financial institutions have arranged private-sector deals involving space worth more than $20 billion, with an estimated $65 billion more required funding new commercial systems during the next five years. ... The root cause for this explosion in space activity has been the ever-widening array of goods and services satellites provide to both the national security (military and intelligence) and commercial sectors."[5]

As this nation explores and exploits the importance of commercial space activities, it must weigh the costs, benefits, and vulnerabilities between "enhancing our security" and bolstering our "economic prosperity."[6] Striking a balance between these two core national security objectives is critical to our nation's future, and essential to providing sound leadership to this nation's space program and more importantly, the international space community. Failure to achieve these objectives of balance and leadership will gravely impact our nation's national security. This paper discusses current national space strategy, law, and policies - focusing predominately on commercial space, explores the four economically prosperous commercial space activities - communications, remote sensing, navigation, and launch - as

well as the implications each of these activities has on our future national security, and concludes with recommendations on how this nation can best posture its space program to gain maximum economic benefits while preserving national security.

NATIONAL SPACE SECTORS

> **"The overarching goal for these times ought to be 'reinventing space' – changing the paradigm from one of space activity directed by the government and often in a manner akin to a public works program, to a space development paradigm in which the private sector takes an active role and carries out projects as economic development ventures."**[7]

On 29 July 1958, President Eisenhower signed the National Aeronautics and Space Act into law. Section 102(b) of this document states,

> " ... the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of, and shall be directed by, Department of Defense..."[8]

This space act gave birth to the nation's first two space sectors, civil and military. The civil space sector encompasses all space activities relating to space science, earth observation, human space flight, and space technologies and applications. The National Aeronautics and Space Agency, established in accordance with Section 202 of this Act,[9] has responsibility for this sector of the United States' space program. The military space sector encompasses all space activities associated with the development of weapons systems, military operations, and the defense of the United States. The Department of Defense has overall responsibility for this space sector.[10] These are the nation's oldest space sectors and were closely followed by the creation of the nation's third and fourth space sectors, the intelligence and the commercial.

The intelligence sector was established in September 1961 with the creation of the National Reconnaissance Office (NRO) and the launch of the nation's first reconnaissance satellite, CORONA. This organization was responsible for designing, building, and operating all the nation's remote sensing and imagery satellite systems and constellations. The NRO conducted its business in extreme secrecy until the Boren Amendment declassified its existence in 1992. The once highly classified program, CORONA, was declassified in February 1995 and over 800,000 CORONA images were transferred to the National Archives and Records Administration, making them available as an open-source product.[11] Although the NRO remains a viable national security organization today, the remote sensing and imagery

activities have become a critical commercial endeavor, leading to our fourth and final space sector, the commercial space sector.

The commercial sector was created in 1962 with the signing of the Communications Satellite Act[12] and the launch of the nation's first commercial communications satellite, Telstar I.[13] This Act established a commercial communications satellite system, as part of an improved global communications network, responsive to public needs and national objectives,[14] and authorized the creation of a non-governmental, communications satellite corporation.[15] Although this Act refers to a commercial space sector in terms of a commercial communications satellite system, it was not until the Reagan Administration's "Presidential Directive on National Space Policy"[16] that this space sector was acknowledged within the nation's space policy arena as a separate and distinct sector. This sector comprises space activities associated with the private business sector and all nongovernmental (NGO) space organizations and is the nation's fastest growing space sector. This has occurred mainly as a result of recent administration policy changes relaxing restrictions on technology transfer between the military and commercial communities and between the U.S. and other nations and changes granting commercial access to previously restricted space activities like detailed, high resolution remote sensing and accurate navigational data.

During the period from the enactment of the National Aeronautics and Space Act in 1958 to the break up of the Soviet Union, space activities were driven by competition between the United States and the Soviet Union in the military and political environments. Within the past decade, space activities have become as important to the commercial sector and the global infrastructure as they were to the military sector. In 1997, the U.S.'s commercial space sector surpassed all other sectors combined in launch and sales.[17] This fast growing sector exceeded $38 billion in revenues for U.S. companies in 1998. It is estimated that by 2007, U.S. commercial satellite revenues will exceed $171 billion.[18] Over 90 percent of this revenue is generated from the communications activities while the remaining 10 percent comes from the remote sensing, navigation, and launch activities.[19]

The increasing national and global importance of these commercial space activities - communications, remote sensing, navigation, and launch - has raised concerns pertaining to this countries national security. Does transitioning of former military and intelligence unique space activities to the commercial space sector impact this nation's national security? If so, then what must be done to alleviate or minimize these concerns? What, if any, are the implications of the explosion of the commercial space sector to this nation's security?

An understanding of current space strategy, law and policies is required before assessing any implications that commercial space sector may have on our national security.

NATIONAL SECURITY STRATEGY AND NATIONAL SPACE POLICY

"... space is not just a military, but also an economic center of gravity, and unarguably, a vital national interest."[20]

—Richard B. Myers, General USAF

Commercial space products and services have significantly contributed to the explosive growth observed in the global information infrastructure and the global economy. The domestic and international importance placed on these two infrastructures, information and economy, has elevated space as one of our national vital interests. "Space has emerged in this decade as a new global information utility with extensive political, diplomatic, military, and economic implications for the United States."[21] The importance of commercial space, a critical environment to this nation's day-to-day business, is addressed in the National Security Strategy and National Space Policy. These documents lay the foundation for how our nation prosecutes activities in and from space.

The key to this nation's continued success and prosperity in space is through sound leadership and vision. Our National Security Strategy states, "We are committed to maintaining our leadership in space."[22] There is no question. We must remain engaged in all aspects of commercial space or prepare to forego the technological and economical benefits being garnered from space, not to mention the impact disengagement from commercial space would have on our national security. Maintaining our leadership role in space through sound space policy towards, and use of, commercial assets will serve to strengthen our national security, foreign policy, and economic goals.

The ways this nation expects to achieve its stated goals - to maintain and ensure continued leadership - in the commercial space sector, is amplified in the National Security Strategy,

> "We seek to ensure a business environment in which the innovation and competitive efforts of the private sector can flourish. To this end, we will continue to encourage the development, commercialization and use of civilian technology. We will invest in a world-class infrastructure for the twenty-first century, including the national information and space infrastructure essential for our knowledge-based economy."[23]

The means to achieve these ways are further delineated within this national level strategic document and link with the commercial activities of communications, remote sensing, navigation, and launch. These means are: to regulate the commercial space-based remote sensing industry to ensure space imagery does not adversely impact U.S. security interests; to promote development of the full range of space-based capabilities in a manner that promotes our vital interests; to ensure unimpeded access to and use of space; to promote prosperity; and, to remain vigilant so we do not compromise our technologically superiority while promoting partnerships in space.[24]

President Bush's Executive Order 12675 established the National Space Council on 20 April 1989. This Executive Order assigned the National Space Council responsibility for providing a coordinated process for developing space strategy and policy and for overseeing the integration of the ways and means to achieve the nation's space policy goals. The Vice President was designated

Chairman of the Council, serving as the President's principal advisor on national space strategy and policy, and the Council was comprised of representatives from twelve cabinet departments and governmental space organizations.[25] Within four years, the National Space Council, with Vice-Presidential level status, was placed under the newly created National Science and Technology Council (NSTC). The NSTC, with the responsibility for reviewing all space related policies and recommending "appropriate changes to related national security directives containing guidance on space policies and programs,"[26] was placed under the National Command Authority, losing its vice-presidential political and policy-making authority.[27]

A large portion of the space industry perceives this change as unhealthy for the nation's space program. Space policies appear driven by different organizations, offices, agencies, and even individuals, depending on the issue and policy. There is a sense of "no White House forum with sufficient balance" to ensure contentious and high level political and policy issues receive the appropriate level of attention.[28] At times, it appears the nation's space and space-related policies are changed to react to global and national situations versus balancing economic, political, and nation security considerations; the latter being required to maintain a strong leadership role in space.

As an example, in 1996, commercial satellites were taken off the U.S. munitions list and export-licensing jurisdiction for these satellites was moved from the Department of State to the Department of Commerce.[29] This policy change was implemented for economic reasons; the U.S. launch activity could not satisfy the communication activity's growing launch requirements leaving the communication activity two alternatives: one, wait in line for the next available U.S. launch facility and lose significant revenue and market share; or two, go off-shore to launch their satellites. In February 1999, after a number of congressional hearings and investigations into the 1996 failed launch of a U.S. commercial satellite from a Chinese facility, this policy was reversed giving responsibility back to the State Department for granting space technology and satellite export licenses. This change was implemented for national security reasons; the investigation raised the issue of possible U.S. space technology transfer. This is an example of reactive policy making. A single focal point for all space-related strategy and policy issues would reduce these "reactive" policy changes.

Advocates for a NSTC counter these arguments by listing the current Administration's numerous accomplishments in developing and implementing space policy. The National Space Policy, Commercial Remote Sensing Policy, National Space Transport Policy, and Global Positioning System Policy are some of the key policies developed by the NSTC in the past seven years.[30] These policies highlight the Administration's commitment to the national space program and commitment towards maintaining a leadership role. Whether the nation requires a National Space Council, with the Vice President as Chairman, a National Science and Technology Council, or a high level Space position on the National Security Council is debatable. However, what is required is a single entity with requisite knowledge of the space sectors and a global insight to provide sound advice to the President. Today, that entity happens to be the NSTC.

After a three-year comprehensive review of all domestic and international space policies, the NSTC shaped a new national space policy that was signed into law on 19 September 1996.[31] The National Space Policy supports the National Security Strategy with the primary goal of ensuring the United States maintains a leadership role in space "by supporting a strong, stable and balanced national space program that serves our goals in national security, foreign policy, economic growth, environmental stewardship, and scientific and technical excellence. Access to and use of space is central for preserving peace and protecting U.S. national security as well as civil and commercial interests."[32] The U.S. space program, as outlined in the National Space Policy, encourages the commercial use of space and has set goals to further enhance and encourage space commerce. These goals include enhancing U.S. economic competitiveness and scientific and technical capabilities and encouraging state, local, and private sector investment in, and use of, space technologies. "Expanding U.S. commercial space activities will generate economic benefits for the Nation and provide the U.S. Government with an increasing range of space goods and services." [33] This policy further delineates specific goals for the four key commercial space activities:

> Communications: "Consistent with Executive Order 12046 and applicable statutes, U.S. Government agencies and departments will ensure that U.S. Government telecommunications policies support a competitive international environment for space-based telecommunications."
>
> Remote-Sensing: "Support the development of U.S. commercial Earth observation capabilities..."
>
> Navigation: "To stimulate private sector investment, ownership, and operation of space assets, the U.S. Government will facilitate stable and predictable U.S. commercial sector access to appropriate U.S. space-related hardware, facilities and data."
>
> Space Launch: "The U.S. Government encourages and will facilitate U.S. private (commercial) sector and state and local government space launch and recovery activities."[34]

The National Security Strategy clearly states the goal of the nation's space program, "to maintain our leadership in space."[35] The National Space Policy further defines the goals and objectives of all the nation's space sectors, including commercial. Additionally, this Policy lays out a few key goals for the commercial sector activities. However, there is no single policy for the commercial space sector, like there is for the national space sector, which is the responsibility of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD (C3I)).[36] The details of each commercial space activity's policies reside in separate policy statements and legislation. Although not part of the National Space Council versus National Science and Technology Council debate, the lack of an overall commercial space policy should be addressed at the highest levels of this government, especially considering the significance this sector has on global economics and the global information infrastructure.

This next section will examine these separate policies and laws governing the four commercial space activities, in addition to rendering a short history, the current status, and the future trends of each

activity. The outcome of this section will provide the requisite foundation to analyze what, if any, implications these trends may have for our national security.

COMMERCIAL SPACE SECTOR

> **"The trend is clear: Commercial investment in space technology is fast outpacing government investment."**[37]

The commercial space sector surpassed all government space sector expenditures and launches for the first time in 1997. The Department of Commerce estimated the revenues from commercial space activities approached $7.5 billion and commercial launches surpassed government launches 2 to 1.[38] Today, over one million personnel, in over 1000 companies, develop, manufacture, or operate space systems worldwide; the United States employees the majority of these personnel. The space industry projects the launch of between 1,500 and 1,800 satellites within the next ten years, representing an investment of over one-half trillion dollars, with the majority of these being commercial satellites.[39]

Communications, remote sensing, navigation, and launch are the four major areas of space contributing to the explosion of the commercialization of space. Commercial communications satellites, the oldest commercial space activity, began orbiting the earth in the early days of space access and contributed significantly to the growth of the global economy. Remote sensing and navigation are relative newcomers to the commercial space sector. These two activities are expanding exponentially and could pose the greatest level of risk to our national security. The launch activity is commercialized worldwide yet remains predominately a government, NASA and USAF, responsibility within the United States.

COMMUNICATIONS

The commercial satellite communications space activity, first recognized as a space sector in 1962 with the passing of the Commercial Satellite Act, is this nation's oldest commercial space activity. This space activity comprises 90 percent of all commercial space revenue with over 140 countries owning or are members of a consortium owning a communications satellite or a satellite constellation. The INTELSAT consortium, a United Nation's-sponsored, not-for-profit, commercial consortium established in 1964, comprises over 139 nations or signatories and is the world's largest supplier of satellite communications service.[40] Satellite communications is the one space activity having the greatest effect on the average citizen.

From the first TELSTAR satellite launched in 1962 and placed in geosynchronous orbit (GEO), to the most recent Globalstar satellites launched in 1999 and placed in low-earth orbit (LEO),[41] communications satellites have brought people, states, and nations closer together. Commercial satellites provide a wide range of communications services to include television programs, telephone service, paging service, digital data links, facsimile transmissions, service between ships and offshore

facilities, customer services extended to aircraft in flight, and a myriad of other data and voice transmission services. Linkage of these services has given rise to the term "global village."[42]

The United States' policy towards this activity remains unchanged since execution of Executive Order 12046, "Relating to the Transfer of Telecommunications Functions", in 1978. This Executive Order transfers responsibility for aiding "in the planning and development of the commercial communications satellite system and (aiding) in the execution of a national program for the operation of such a system" to the Department of Commerce.[43] Communications satellites have greatly contributed to the exponential growth of the data and voice communications industries, and the satellite communications industry is second only to the computer industry in technological evolution and rapid innovation.[44]

The commercial communications space activity's future outlook is promising. The trends in this activity are moving toward smaller antennas, greater bandwidth capacity, and lighter, smaller, more mobile ground terminals. The communications satellite activity is headed towards a technology where individuals, businesses, and organizations will have a "personal" number valid everywhere in the world. Iridium's technology supports this capability, although the "Iridium" capability has not fully developed causing the company to file for bankruptcy in late 1999.[45] It is only a matter of time before this technology matures.

Due to a declining defense budget, the increasing reliance on satellite communications, and the technological advances being made by the commercial space communications sector, the U.S. military will rely more and more on commercial satellites to fulfill its growing telecommunications requirements.

> "The rapid pace of advancements in more capable and more affordable commercial SATCOM technology, occurring independent of military needs, is offering new, even revolutionary, capabilities that can be exploited to meet the warfighters' and their supporting activities' rapidly growing information needs. These new capabilities combined with innovative acquisition and leasing strategies, have caused DoD to rethink how it acquires, uses, and manages commercial resources."[46]

By 2010, it is conceivable that only one or two military communication satellite constellations will provide dedicated support to the Department of Defense's "protected" users.[47] These users require survivable communications for control of nuclear forces, a capability not cost effective for the commercial industry to provide. Commercial communication satellites will satisfy all other requirements; these satellites could include foreign owned or consortiums with foreign members. Transitioning to a heavier reliance on commercial satellites to satisfy requirements is more economically attractive, however it poses some national security issues that will be discussed in a later section.

REMOTE SENSING

Until the early 1990's, the military and intelligence space sectors owned the remote sensing activity; economics was not a factor in formulating this activity's policies. Imagery produced by space assets was strongly regulated in the interest of preserving national security. Prior to 1992, the Commerce Department granted only two commercial imagery satellite licenses, one of which was Landsat.[48] Today,

commercial remote sensing systems are one of the fastest growing space activities with over a half-dozen U.S. companies having satellites on orbit. The Commerce Department estimates that by the end of 2000 the commercial imagery sales and services will top $2 billion, a six-fold increase in five years, and at least a dozen countries will possess this capability.[49]

The National Reconnaissance Office (NRO) was created in 1962 and remained our nation's premier remote sensing organization during the Cold War. Today, this once secret organization is relying more and more on commercial imaging activities for its imaging products. In March 1999, the NRO and the United States National Imagery and Mapping Agency (NIMA) committed $1 billion over six years to commercial imagery.[50] Russia, France, and India are also commercially marketing photos taken from their satellite imagery systems. The Russian Kosmos KVR-1000, French Spot, and Indian IRS-1C satellites produce photos with two to six meter resolutions, meaning objects between two and six meters in width are recognizable from their respective imagery satellite. The United States' Space Imagery, Corp. successfully launched its first Ikonos (pronounced eye-KOH-nos) satellite in September 1999. Ikonos, meaning 'image' in Greek, is the first commercial one-meter resolution satellite. Mr. Copple, the president of Space Imagery, Corp., said imagery from this satellite would "cost $25 to $300 a square mile and that the minimum size of the ground area would probably be larger than a square mile."[51] Space Imagery is selling this imagery via its Web site today.[52]

U.S. space-based remote-sensing remained solely in the government domain for many years, and it was not until the French and Russians began commercializing their imagery systems that the United States eased restrictions on its remote sensing space activity. The Land Remote Sensing Act of 1992 recognized that, "The national interest of the United States lies in maintaining international leadership in satellite remote sensing and in broadly promoting the beneficial use of remote sensing date."[53] That same year a license was granted for a three-meter resolution satellite.[54] Presidential Decision Directive (PDD) 23[55] was signed two years later lifting technical restrictions on commercial imagery and creating broader opportunities for U.S. companies in the global commercial marketplace. This deregulation gave U.S. companies authority to develop, sell, and operate remote-sensing satellites with resolution capabilities of up to one meter. This directive was applauded as it allowed U.S. satellite firms to begin competing with foreign firms in this booming space activity; an activity predicted to reach revenues of $2 billion by the end of 2000.

The overall goal of this nation's remote sensing policy is "to support and enhance U.S. industrial competitiveness while protecting U.S. national security and foreign policy interest."[56] The government retains the right to direct U.S. companies to turn off their cameras during periods when our national security is jeopardized or during times of international crisis or war; this action is referred to as 'shutter control.' The government also reserves the right to screen and limit which foreign customers and countries can purchase imagery from American companies.[57]

The demand for short duration, high-resolution imagery is unlimited. Future markets will include state and local governments, agriculture, environmental management, insurance and risk management, land management, mapping, real estate, transportation, utilities, and of course, the market which dominated this activity until the mid-1990's, national security.

> "The market is in its infancy but has huge potential. Remote sensing will become an essential part of the information revolution. ... Worldwide commerce in high-resolution imagery has significant positive and some negative implications. On the negative side, how does the military deal with adversaries who can access up-to-date imagery benchmarked against GPS on their personal computers through the Internet? Not only will ensuring the element of surprise in military operations be infinitely more difficult, the imagery becomes the targeting database for the rogue nation or terrorist."[58]

Approximately a dozen commercial remote sensing satellite constellations are projected to be operational in the next decade. This doubles the number of current remote sensing constellations in operation and enables the proliferation of imagery products for numerous purposes. Some deemed harmful to our nation and our allies, but the majority projected for humanitarian and business purposes.

Another relatively new activity within the commercial space sector, and an activity receiving as much, if not more, economic and national security attention is the navigation activity.

NAVIGATION

The first satellite-based navigation system, Transit, was launched in 1959 to support the Navy's submarine fleet.[59] Over the next twenty-five years, all successive U.S. space-based navigation systems were designed for national security purposes. It was not until the downing of Korean Air flight 007 by the Soviet Union in 1983 that U.S. space-based navigation policy changed allowing civilian use of this capability. On 16 September 1983, President Reagan announced the United States would make the Global Positioning System (GPS) available for civilian aircraft once the system became operational.[60] The Department of Transportation was granted lead agency for defining and setting commercial space-based navigation policy.

The Global Positioning System constellation consists of 24 satellites. GPS is a military built and controlled system costing the Department of Defense over $10 billion to operationalize. The system is designed to ensure at least four satellites are above the horizon for every point on earth providing the user maximum location accuracy. These satellites transmit two distinct signals: a Precision, or P, code designed for military users and providing accuracy of better than 20 meters; and a Course Acquisition, or C/A, code designed for commercial users providing accuracy of between 100 and 200 meters.[61] Although there are technical restrictions preventing civilian users from accessing the military's more precise P-code, the system has become one of the fastest growing space activities.

No one could have envisioned the exponential growth of commercial GPS applications. GPS was put up for national security purposes, but an entire commercial industry was created.[62] Today, there are over 300 companies using GPS hardware in a myriad of industries, to include aviation, communications, environmental protection, law enforcement and safety, ground transportation, maritime and waterways

operations, and public safety to name just a few. Worldwide revenues reached $500 million in 1993, just two years after the Gulf War, where GPS gained instant fame. By 1998, revenues exceeded $4 billion and are expected to reach $16 billion by 2003.[63] Once a predominately military system, civilian applications exceed military applications by a ratio of 8 to 1,[64] and industry experts predict commercial users will account for over 98% of the GPS market by the end of 2000."[65] Although currently unable to access the military's P-Code, commercial users are achieving increased accuracy by using a technique called Differential GPS (DGPS). This technique coalesces the use of GPS with ground-based systems and provides greater accuracy for all commercial users, friendly or hostile toward our nation and our Allies.[66]

By 1996, the U.S. government recognized that GPS was becoming an integral component of emerging global economic and information infrastructures. On 29 March 1996, the Clinton Administration signed the U.S. Global Positioning System Policy. The policy's primary goal seeks to maintain the nation's leadership role in the area of space-based navigation by supporting and enhancing economic competitiveness and productivity while protecting national security interests. [67] To the fullest extent possible, the GPS Policy seeks to balance national security with commercial endeavors; the U.S. government does not wish to interfere with the commercial space sector's GPS activities unless for national security or safety reasons. The Department of Defense retains responsibility for acquiring, maintaining, and operating the GPS, while the Department of Transportation has lead agency responsibility within the U.S. Government for all Federal civil GPS matters and for promoting commercial applications of GPS.[68]

On 25 January 1999, the White House announced a new GPS modernization initiative. Given current launch schedules and projections, the GPS constellation will be upgraded with two new civilian signals by 2006. When integrated with the current signal, these additional signals will significantly improve the accuracy and reliability of the GPS for commercial users, and "will enable unprecedented real-time determination of highly accurate position location anywhere on Earth."[69] The intent of this initiative is to spur new commercial applications for GPS and ensure the U.S. remains the world leader in this space activity. The Department of Defense was given the responsibility of developing measures to prevent the hostile use of GPS and its augmentations and ensuring the U.S. military and its allies retain military advantage without disrupting or degrading civilian uses.[70]

There are no international standards for this industry, which, if not properly addressed, could fragment global markets into less attractive portions especially when, not if, other countries or corporations place a navigational system in orbit. Fragmentation of this market could discourage space commercial vendors from entering this market. GPS and the Russian equivalent system, GLOSNASS, are the only space-based navigation systems in existence today. Both constellations are government controlled and will remain government controlled for the foreseeable future. Cost of operating and maintaining these systems are not transferred to the consumer. However, this also means that U.S. and

Russia have technical and political control over when and where these systems are accessed. The European community is seriously investigating the feasibility of developing and operating their own navigational system of satellites. To gain leverage and control in this space activity, the European Union and their space organization, the European Space Agency, are considering developing a Global Navigation Satellite System, GNSS-2, or Galileo.[71] This endeavor is currently under investigation and no date has been set for further development of the system. U.S. must work with the international community to develop internationally agreed upon standards for future system. Lack of standards will not only fragment the market place but cause problems in an already crowded frequency spectrum.

The explosion of the commercial space sector has impacted not only the activities requiring on-orbit satellites, but just as importantly, has impacted the launch activity.

LAUNCH

The commercial space launch industry is changing as fast as the commercial satellite industry. From the mid-1970's through the mid-1990's, the U.S. conducted, on average, 23 launches annually. Government launches comprised 75 to 80 percent of the launch business. By 1996, commercial launches exceeded government launches and are expected to continue to grab increasingly more of the launch business in the future.[72]

As the U.S. space launch industry was increasing its commercial launches relative to government launches, it quickly lost the edge and the leadership role in the world's non-governmental launch activity. The U.S. launched 100 percent of all the world's commercial satellites prior to 1978. Today, the U.S. launches less than 40 percent of the world's commercial satellites, the U.S.'s smallest portion of the global launches industry to date.[73] There are at least eighteen launch facilities in nine countries, plus a sea-based launched facility. The United States government owns three of these facilities, and Boeing, a U.S. provider of space launch and satellite capabilities, is part owner of the sea-based launch facility, which successfully launched its first satellite in October 1999.[74]

Four families of expendable vehicles comprise the U.S. commercial space launch inventory – Athena, Atlas, Delta, and Titan; only two companies, Boeing and Lockheed-Martin, build these vehicles. "The current launch vehicles are based on Inter-Continental Ballistic Missile technology of the 1960's. While they have adequate performance, they are manpower intensive and expensive. They were designed to maximize performance and not to provide economical access into orbit. Reliability was pursued through inspection and redundancy."[75] These two factors drove up the cost of production, which was of minimal concern during the Cold War era.

NASA and the U.S. Air Force had the responsibility for providing access to space for civil, commercial, and government missions until 30 October 1984 when the Commercial Space Launch Act[76] was signed. This legislation was passed as a result of the Challenger Shuttle disaster earlier in the year. The United States had placed its entire launch capability with the Shuttle program; access to space was

at a standstill in the U.S. the moment the Challenger was destroyed. This Act was the catalyst for turning around a very dismal situation.

The purpose of the Act was "to encourage the United States private sector to provide launch vehicles and associated launch services by simplifying and expediting the issuance and transfer of commercial launch licenses and by facilitating and encouraging the utilization of Government-developed space technology."[77] The Department of Transportation, in coordination with the Department of Defense on national security matters and the Department of State on foreign policy matters, was given overall responsibility for implementing this legislation.[78]

In subsequent years, the launch capability did not improve. The launch costs from a U.S. facility was considerably more than from other launch facilities in the world. It costs between $75 and $150 million to launch a commercial payload into orbit from the United States today. The Russians and Chinese launch commercial satellites for about $25 to $45 million. Russia recently launched back-to-back vehicles, the Proton, within two weeks of each other using the same launch pad. Launch asset availability has significantly improved in those two countries. The United States, however, still lacks the capability to refit its launch facilities for relatively quick back-to-back launches. "Lowering the cost of access to space is the most important issue in promoting space development."[79] The high cost of launching from the U.S. and the lack of available launch facilities drove U.S. businesses to seek approval for their satellites to be launched from foreign facilities, to include China. This was approved in the late 1980's when President Reagan authorized the use of Chinese rockets to launch U.S.-made commercial satellites.[80]

National Space Transportation Policy, dated 5 August 1994, "set a clear course for the nation's space program, providing a coherent strategy for supporting and strengthening U.S. space launch capability to meet the growing needs of the civilian, national security and commercial sectors."[81] This policy commits the nation to a two-track strategy of: "(1) maintaining and improving the current fleet of expendable launch vehicles as necessary to meet civil, commercial, and national security requirements; and (2) investing R&D resources in developing and demonstrating next generation reusable space transportation systems with the potential to greatly reduce the cost of access to space."[82] This policy set in place the strategy to pursue low-cost access to space, recognizing the need to reestablish the nation as a leader in launch capability.

Four years after release of this policy, the U.S. government announced $3 billion in government contract awards for private industry to develop two families of Evolved Expendable Launch Vehicles (EELV's). The nation's next generation launch vehicles are projected to reduce launch costs by 25 to 50 percent over twenty years.[83] These vehicles "will provide enhanced mass-to-orbit capability, broader operational flexibility, over $1 billion in launch infrastructure upgrades, and the formal transition to commercial launch services for all AF and NRO payloads."[84] The EELV, along with Sea Launch, new versions of the Atlas and Delta vehicles, and possibly some smaller launchers are the answer to this

nation's future in "on-demand" space access. All of these potential launch systems point to significant near-term gains in this critical space activity. [85]

These initiatives, if cost reductions bear out, should regain lost commercial launch business for U.S. corporations. The business of space launch, with over 1500 satellites scheduled for launch in the next decade, will become increasingly competitive in the future.

NATIONAL SECURITY IMPLICATIONS

"Until the early 1990s, security considerations have always won, but that balance has begun to shift." [86]

A policy that restricts America's commercial sector from foreign space markets has negative implications towards our economic prosperity, just as a policy that supports unrestricted trade and a free and open market for the sale of space technologies and products has negative implications towards our national security. A policy restricting commercial competition will ultimately open the door to greater competition from other countries and will degrade this nation's leadership role in space. A policy minimizing national security concerns could result in the deterioration of our global leadership role. Within the past decade, each commercial space activity grew exponentially. This expansion commercial space products and services causes national security concern and has implications towards our nation's overall security. These concerns and implications are discussed below.

COMMUNICATIONS

The Commercial Space Act of 1962 created the U.S. commercial space communications sector. Our national security sector - military and intelligence - relies on commercial satellites to satisfy bandwidth requirements not supported by military communications satellites. With the decrease in the Defense Department's budget over the past decade and the benefits realized by leasing commercial communications, reliance on commercial communications satellites for national security purposes continues to increase. The National Security Space (NSS) Architecture is driving to a commercial-like solution for all but the most 'protected' of our satellite communications users. A very minimal number of military satellite communications constellations are projected beyond the year 2010.[87]

The implications to our national security of a more commercial-like architecture are three fold. First, commercial satellites are not built to the stricter military specifications; military satellites must operate through stressed environments and require non-commercial features like hardening, jam resistant, beam nulling, and netted communications.[88] Second, our adversaries may use the same communications satellites we use, and the satellite owner(s) may not be willing to deny our adversaries access during periods of increased hostilities or war. Finally, reliance on only a few military satellite constellations could severely hamper our command and control capabilities if anything happened to those constellations.

Commercial vendors are in business for one reason, to gain enough market shares in their respective industry to make a profit. If military standards, many of which were developed during the Cold War era to enhance our national security space sector's survivability, are not required on commercial satellites and do not contribute to the industry's bottom-line, then industry will not integrate these features into their satellites.[89] Monetary incentives, partnering between the national security and commercial sectors early on in the research and development of new technologies, and development of a CRAF-like (Civil Reserve Air Force) approach to satisfy periods of expanding national security requirements are three means by which national security and commercial sectors can work together to decrease the impact commercial communications satellites have towards our national security and improve this space activities position in the world space market.

Adequate and redundant communication services are key to minimizing national security implications caused by the decrease in reliance on military communications satellites and the increase in reliance on the commercial communications activity. The May 1998 failure of the PanAmSat Galaxy IV satellite is a lesson in ensuring redundancy is built into any architecture. "The on-board computer processors failed causing the satellite to lose altitude. The outage caused significant communications problems for the economic sectors in the U.S. including over 90 percent of the U.S. pager customer."[90] This real example shows the significant just one satellite has on an economy.

REMOTE SENSING

Commercial remote sensing has significant implications to our national security. Encouraging firms to participate in this market enables any customer ready access to images that could potentially impact our national security, like images of deployed forces or troop movements. Restricting U.S. firms from competing in this fast growing market could not only cause them to lose their technological advantage in this area, but might force them to divest themselves from the remote sensing activity altogether. The second and third order effects could cause the U.S. to lose its leadership role in this sector, a serious national security implication.

Advocates of a more restrictive remote sensing policy believe traditional means, i.e. aircraft, are more readily available and cheaper than space-based imagery systems. Most areas on earth can be easily imaged or photographed via aircraft and it's cheaper than placing a satellite on orbit. These advocates state the only real reason for a customer wanting space-based imagery is because they cannot obtain over flight rights or they do not want the 'owner of the property' to know they are imaging the area. Whether one-meter resolution is too small and not commercially feasible is unknown, but the market place will determine this answer after one-meter resolution remote-sensing satellites, like the Ikonos, have had a few years to test the commercial market.

The commercial remote sensing activity, and specifically the one-meter resolution imagery, is available, and whether it negatively impacts our national security or not, it is doubtful U.S. policy towards this activity will change. Retired General Horner puts this situation in very clear terms, "... by getting into

the market, we can meet legitimate needs of countries and that will permit us to have some control over this in wartime. It's a way of fighting the space control mission. If it's our economy that's selling the imagery, that means when the war occurs, we can define the export terms."[91] He goes on to say, "The free market will take over.... If you don't build them in Europe, and we don't build them in the United States, Russia is certainly going to build them."[92] This argument suggests that establishing American leadership in this market would prevent or delay entry of others into the market. As the dominant force in this market, the U.S. would be in a better position to control or delay dissemination of space-based imagery that negatively impacts its national security, like it did with the "shutter control" and "imagery denial" policy towards remote sensing satellites when flying over Israel. Although these are means to control imagery production and dissemination, these are not fail-safe measures. Just like weapons of mass destruction, nations can obtain images from alternative sources that decide not to adhere to U.N. or U.S. policies or agreements.

NAVIGATION

Like the Internet, the Global Positioning System "is a valued utility for the emerging Global Information Infrastructure" and has contributed significantly to the global economy over the past ten years.[93] The GPS was designed as a dual-use system, one code (C/A) services civilian users and one code (P) services military users. During periods of threats to our national security, the U.S. has the capability to degrade civilian accuracy through a capability called selective availability. By 2006, civilian accuracy will improve through the availability of two additional frequencies, and the selective availability feature will be turned off.[94]

The risk to our national security does not rest with the fact that our adversaries can obtain the same navigational accuracy as our military. The risk lies in the potential for the U.S. to lose its role as the premier space-based navigation leader. If the U.S. denies the commercial sector the same level of accuracy as the military, then another country, corporation, or consortium will step-up and fill the void by placing a navigational satellite constellation on orbit. The European Community and European Space Agency have initiated preliminary studies addressing the feasibility of owning their own space-based navigation system for national security reasons. The Europeans have not received assurance from the United States that they will have unrestricted access to GPS. They do not want to continue relying on GPS, if U.S. assurance is not given, or rely on the GLOSNASS system, where economic conditions in Russia have threatened this system's viability.[95]

If the U.S. policy is to deny civilian access of GPS during heightened levels of tension or hostilities, then the European community has made it clear they will pursue their own navigational system. If the U.S. continues to pursue its present policy of dual-use, same level of accuracy, then the U.S. can be fairly certain the European's will not develop their system in the immediate future.

The 1996 GPS Policy gives the U.S. Department of Defense another six years to shape the GPS environment, specifically how the military will receive accurate and continual GPS data while denying this

capability to any adversary at any time. The Department of Defense is developing a "system to deny use of GPS to the enemy while protecting use for legitimate civilian users outside the conflict areas."[96]

LAUNCH

Of the four commercial space activities, the commercial launch activity posses the greatest threat to our national security. The National Defense Panel highlighted a number of vulnerabilities in our nation's launch activity: the small numbers of launch facilities; the present launch processes; and the current operations and maintenance costs.[97] The U.S. government must implement economically profitable measures to lower launch activity costs. If not, then the commercial satellite providers will take their business to foreign launch facilities. In addition to lowering launch costs, "failure to develop this next-generation (launch) capability will be a missed opportunity for America to regain market share in the global launch services competition."[98] The U.S. government has partnered with industry to develop the next generation EELV, and the Boeing Corporation is the majority shareholder in the Sea Launch Co., based out of Long Beach, CA. These two endeavors should improve this nation's ability to access space but improving our launch facilities is just as critical to our national security.

Retaining the nation's launch facilities under full government control has a number of negative attributes. First, launch costs remain high. Second, commercial satellite providers will continue to migrate to less expensive foreign launch providers. Third, the nation's launch activity will lose more commercial launch market shares. Fourth, U.S. corporations and the U.S economy will lose substantial revenue from this space activity. Finally, the U.S. will not dominate the space launch activity and will continue to lose its leadership role in space, negatively impacting national security.

The Department of Defense continues to integrate the commercial space sector with the national security space sector in the areas of communications, navigation, and remote sensing. There is no reason to believe integrating commercial launch with the nation's current launch organizations, or even completely privatizing the nation's launch capability, would negatively impact national security. On the contrary, competition in the launch business will drive down costs, increase launches, increase revenue for our nation's space industry, and ensure this nation remains competitive, and a world leader, in this space activity.

Accessing space is the key to space. A sound launch capability assures this nation retains the ability to get into space when it wants to and is not constrained by launch facility issues.

RECOMMENDATIONS

> **"Our national space transportation capabilities are critical to the overall strength and stability of our commercial, civil, and national space sectors. As we enter the 21st century, reliable access to space will be more important than ever in accomplishing our national goals."[99]**
>
> **—President William J. Clinton**

Commercial space is a "killer app."[100] Over the past decade, there has been an explosion in the commercial space sector and industry analysts project this growth to continue at a rate of 20 percent annually.

- The sector's communications activity captures approximately 90 percent of the $65 billion global commercial space revenue with expectations that investments will exceed $450 billion in on-orbit assets over the next ten years. Satellite communications constellations have grown from predominately a four to six satellite constellation at geostationary orbit, to constellations projected to contain as many as 255 satellites circling the earth at low earth orbit.
- The commercial remote sensing activity has transitioned from a two-satellite activity in the 1980's to a twelve-satellite activity and is projected to capture $8 billion in revenue in 2000, a six-fold increase in five years.
- U.S. policy only recently authorized civilian access to the space-based navigation when the GPS constellation became operational in the early 1990's. The space industry projects this activity will net over $5 billion by the end of 2000, a ten-fold increase in seven years.
- Finally, commercial launches surpassed military launches in 1996 and the commercial launch activity expanded to over eighteen launch facilities located in nine countries and a sea-based launch facility. The commercial launch activity is projected to support the communications, remote sensing, and navigation activities by launching over 1500 satellites within the next ten years.

The United States has kept pace with the global change in the commercial space sector by implemented a number of commercial space related policies. Many of these policies addressed a single activity, and only one of these policies, the National Space Policy, addressed the entire commercial space sector. The remote sensing and navigation activities have transitioned from supporting predominately military and national security assets to supporting increasingly more commercial assets. Imagery is available via the Internet at one-meter resolution, although it will take a couple years before the true commercial value of this product is realized. Position and location data is available for military and civilian users to the same accuracy level. Launch has remained predominately a NASA and USAF responsibility with three launch facilities available to the commercial sector at the government's discretion. However, actions are on going to develop the next generation launch vehicles, and the Sea Launch, Co. has made sea-based launch a reality.

Space capabilities have become absolutely essential to not only military operations but also to the global economy and our day-to-day lives. The space products and services provided today cannot be taken away from the commercial sector which means anyone can purchase quality images of anywhere on earth, can navigate down to within meters of a location, and can communications from almost anywhere, at anytime. Our allies, and our adversaries alike, have the means to access the same space-

based capabilities that we can access. This poses risks to our national security, but these risks can be minimized.

As the international communities' premier leader in space, our nation can shape and change the global environment for space systems by our actions today.[101] Preventing another nation or hostile group from obtaining space products and services is relatively impossible in today's open and free environment. In contrast, four actions can be implemented at the national level to improve this nation's position as a leader in space and decrease the chances of adversaries obtaining space products and services from our allies and partners.

A. Empower a single entity, like the former National Space Council, or an organization like the current National Science and Technology Council, with requisite knowledge of the space sectors and a global insight to provide sound space policy advise to the President; advise which encompasses all space sectors. This organization should have a level of authority commensurate with to that which was granted the National Space Council – a Vice-Presidential level of authority.

B. Promote peaceful cooperation with our international space partners. As a global space leader, this nation must continue to foster international partnering with the spacefaring nations.

C. Continue to foster a strong and vigorous partnership between the U.S. government and the U.S. space industry.

D. Exploit technological successes of the commercial space sector. In the past, military space applications found their way into the commercial sector. With the decrease in military funding available for space research and development, it is imperative that the national security sector exploits, through partnering, the commercial space sectors' technological successes.

Whether the nation is driven economically or militarily, its number one concern relative to space must be access and control. To ensure access means ensuring a leadership role in all facets of space, to include the commercial space sector and specifically ensuring a robust launch activity. To have control means to ensuring assets are protected and accessible when required.

CONCLUSION

Space is no longer strictly a national security domain. The world's growing economy and information infrastructure depends on space products and services for their survival. Recognizing and accepting this change, while simultaneously formulating national space policy that capitalizes on this change, will help ensure this nation remains a key, if not the key, leader in space in the future. Failure to accept this change will ultimately impact this nation's ability to leverage itself within the international space community.

WORD COUNT (8995)

ENDNOTES

[1] Robert S. Dudney, "The New Space Plan," Air Force Magazine 81, no. 7 (July 1998): 23.

[2] Although not listed in the A National Security Strategy for a New Century (Washington, D.C.: The White House, October 1998) as a vital interest, space has become essential for 'our economic well-being', as well as the well-being of the global economy and the global information infrastructure. As described on page 5 of this strategy document, national interests are separated into three categories: vital interests, important national interests, and humanitarian and other interests. Vital interests are "those of broad, overriding importance to the survival, safety and vitality of our nation. Among these are the physical security of our territory and that of our allies, the safety of our citizens, our economic well-being and the protection of our critical infrastructure." Space has become "important to the survival, safety and vitality of our nation," therefore is a vital national interest.

[3] "State of the Space Industry - 1999," available from <http://www.gn.apc.org/acp/space/state-of-space.html>; Internet; accessed 16 February 2000.

[4] Throughout this paper, I will refer to **space industry**, **space sectors**, and **space activities**. These terms have different meanings and are hierarchical. **Space industry** encompasses all aspects of a space program – public and private, military and commercial. A **space sector** is a subset of the space industry and is a distinct national level domain (military, civilian, and commercial being three examples) with interests in space. A **space activity** is a subset of a space sector and is a functional capability. For the purpose of this paper, space activities are communications, remote sensing, navigation, and launch.

[5] Frank G. Klotz, Space, Commerce, and National Security (New York, N.Y.: Council on Foreign Relations Press, 1998), 6-7. Military, civil, intelligence, and commercial are the nation's original space sectors as identified by the United States' National Aeronautics and Space Act of 1958 and the Commercial Space Act of 1962. The current National Space Policy dated 26 March 1996 lists the sectors of space as civil, national security, commercial, and intersector. The military and intelligence sectors are sub-sectors of the national security sector. See (1) National Aeronautics and Space Act of 1958, Unites States Code Congressional and Administrative News, 85th Cong., 2nd sess., 1958 (St. Paul: West Publishing Co., 1959), vol. 1, 502-517; (2) Communications Satellite Act of 1962, United States Code Congressional and Administrative News, 87th Cong., 2nd sess., 1962 (St. Paul: West Publishing Co., 1963), vol. 1, 489-98; and (3) William J. Clinton, National Space Policy, (Washington, D.C.: The White House, 19 September 1996).

[6] William J. Clinton, A National Security Strategy for a New Century (Washington, D.C.: The White House, October 1998), iii.

[7] Joan Johnson-Freese and Roger Handberg, Space, The Dormant Frontier: Changing the Paradigm for the 21st Century (Westport, CT: Praeger, 1997), 13.

[8] National Aeronautics and Space Act of 1958, 502.

[9] Ibid., 505.

[10] Ibid., 502.

[11] "Who We Are," linked from National Reconnaissance Office, at "Background," available from <http://www.nro.odci.gov/background.html>; Internet; accessed 10 January 2000.

[12] Communications Satellite Act of 1962, 489.

[13] David J. Whalen, "Communications Satellites: Making the Global Village Possible," available from <http://www.hq.nasa.gov/office/pao/History/satcomhistory.html>; Internet; accessed 10 January 2000.

[14] Communications Satellite Act of 1962, 489.

[15] Ibid., 493-494. The Communications Satellite Corporation (COMSAT) was formed as a result of this Act.

[16] "Presidential Directive on National Space Policy- A Fact Sheet," 11 February 1988; available from <http://www.hq.nasa.gov/office/pao/History/policy88.html>; Internet; accessed 10 January 2000.

[17] "Commercialization, Trade and National Security," 6 April 1999; Remarks made by Mr. Clayton Mowry, Executive Director, Satellite Industry Association given at the 15th National Space Symposium, Colorado Springs, CO., available from <http://ussf.iex/net/symposium99/proceedings/trade_and_national_security.html>; Internet; accessed 28 December 1999.

[18] Richard D. Fisher, "Commercial Space Cooperation Should Not Harm National Security," 26 June 1998; linked from The Heritage Foundation, at "Backgrounder," available from <http://www.heritage.org/library/background/bg1198.html>; Internet; accessed 10 November 1999. The author, Mr. Fisher, obtained this data from Merrill Lynch.

[19] "Space Transportation and the Global Space Commerce Market," 28 October 1998; available from <http://www.futron.com/AIAAFNL2.pdf>; Internet; accessed 4 December 1999. See slides no. 4 and 40. This briefing was presented at the AIAA Defense and Civil Space Programs Conference.

[20] Richard B. Myers, GEN (USAF), "Implementing our Vision for Space Control," 7 April 1999; available from <http://www.spacecom.af.mil/usspace/speech15.htm>; Internet; accessed 16 December 1999. Speech given to the United States Space Foundation, Colorado Springs, CO.

[21] Clinton, A National Security Strategy for a New Century, 25.

[22] Ibid.

[23] Ibid., 29.

[24] Ibid., 25.

[25] White House, Office of the President of the United States, "Executive Order 12675 – Establishing the National Space Council," 20 April 1989, available from <http://envirotext.eh.doe.gov/data/eos/bush/19890420.html>; Internet; accessed 22 January 2000.

[26] Ibid.

[27] "Presidential Review Directive/NSTC-2," 15 May 1995, available from <http://www.hq.nasa.gov/office/codez/history/f2.htm>; Internet; accessed 22 January 2000.

[28] "The National Space Council – Putting Space Back on the Political Agenda," available from <http://ussf.iex.net/symposium99/proceedings/national_space_council.html>; Internet; accessed 14 February 2000.

[29] "Commercial Space Launch and Foreign ICBM Programs," linked from Federation of American Scientists at "Space" available from <http://www.fas.org/spp/starwars/congress/1998_h/s980521t.htm>; Internet; accessed 3 January 2000.

[30] Ibid. In addition see, White House, Office of the Press Secretary, "Fact Sheet - Clinton Administration Space Accomplishments," 30 October 1998; available from <http://www.reston.com/nasa/white.house/10.30.98.accomplishments.html>; Internet; accessed on 28 December 1999.

[31] Clinton, National Space Policy.

[32] Ibid.,1.

[33] Ibid., 6.

[34] Ibid., 6-7.

[35] Clinton, A National Strategy for a New Century, 25.

[36] Department of Defense, Defense Department Space Policy, (Washington, D.C.: The Pentagon, 9 July 1999).

[37] Katherine McIntire Peters, "Space Wars," Government Executive 30 (April 1998): 13.

[38] Scott Pace, "Promoting Commercial Space Activity," 31 July 1996; Prepared statement for the record of Scott Pace, Ph.D., The Rand Corporation, before the U. S. House of Representatives Subcommittee on Space and Aeronautics; available from <http://www.house.gov/science/scott_pace.htm>; Internet; accessed 28 December 1999

[39] Klotz, 6-7.

[40] Army Training and Doctrine Command, "1998-1999, The Army Satellite Communications Architecture Book," (Reston, VA.: ITAC, December 1998), 6-13.

[41] Communications satellites are located at Geostationary Orbit (GEO), Medium Earth Orbit (MEO), Low Earth Orbit (LEO), or Molniya Orbit. A satellite at geostationary orbit (GEO) is positioned at approximately 22,300 miles above the surface of the earth and is synchronized with the earth's rotation, keeping it positioned above the same point on earth. A satellite at a medium earth orbit is positioned at approximately 12,500 miles above the surface of the earth and rotates around the earth twice in one day. A satellite placed in a low earth orbit is positioned at approximately 500 miles above the surface of the earth but can also reach altitudes of 1,500 miles. The Molynia orbit is highly elliptical with a perigee (low point) of approximately 1000 kilometers and an apogee (high point) of approximately 39,400 kilometers.

[42] Whalen.

[43] White House, Office of the President of the United States, "Executive Order 12046 – Relating to the transfer of telecommunications functions," 27 March 1978; available from <http://www.nara.gov/fedreg/eos/e12046.html>; Internet; accessed 11 January 2000.

[44] Army Training and Doctrine Command, 6-30.

[45] Sam Silverstein, "Satellite Industry Wrestles with Financing, U.S. Laws," Space News (13 December 1999): 20.

[46] Department of Defense, "Advanced Military Satellite Communications CAPSTONE Requirements Document," (Colorado Springs, CO.; U.S. Space Command, 24 April 1998), 1-11.

[47] Ibid., 1-11 thru 1-18. Protected users include National Command Authority and Single Integrated Operations Plan (SIOP) users.

[48] Peters, 13.

[49] Ibid., 13 - 14.

[50] "1999 – The Year in Review: The Highs and Lows of a Year in Space," Space News (13 December 1999): 14.

[51] William J. Broad, "Private Spy in Space to Rival Military," 27 April 1999; available from <http://www.fas.org/eye/042799sci-spy-satellites.htm>; Internet; accessed 3 January 2000.

[52] Space Imagery, Inc.'s web site is located at <http://www.spaceimagery.com>.

[53] Land Remote Sensing Act of 1992, United States Code Congressional and Administrative News, 102nd Cong., 2nd sess., 1992 (St. Paul: West Publishing Co., 1993), vol. 3, 4163.

[54] William J. Broad, "Commercial Use of Spy Satellites to Begin; Private Ventures Hope for Profits," New York Times, 10 February 1997, sec.B, p.7.

[55] White House, Office of the Press Secretary, "Foreign Access to Remote Sensing Space Capabilities – Fact Sheet," 10 March 1994; available from <http://www.whitehouse.gov/wh94imagery.htm>; Internet; accessed 12 October 1999. This document contains the Statement by the Press Secretary announcing the signing of the Commercial Remote Sensing Act of 1994, and a fact sheet outlining the main goals and objectives of this Act.

[56] Ibid.

[57] Ibid.

[58] Thomas S. Moorman, GEN (USAF/Ret), "The Explosion of Commercial Space and Implications for National Security," Airpower Journal (Spring 1999): 16.

[59] Scott Pace and James E. Wilson, Global Positioning System - Market Projections and Trends in the Newest Global Information Utility, (Santa Monica, CA.: RAND, 1998), 87. An excellent source for information pertaining to all aspects of GPS.

[60] Scott Pace et. al., The Global Positioning System – Accessing National Policies (Santa Monica, CA.: RAND, 1995), 273. A copy of the statement released by the Principal Deputy Press Secretary for the President is found on page 273. The press release states the GPS constellation would be operational in 1988. It was actually declared an operational system in 1994.

[61] Pace and Wilson, 7-8.

[62] Peters, 16.

[63] Ibid., 5.

[64] "A Policy Direction for the Global Positioning System: Balancing National Security and Commercial Interests," available from <http://www.rand.org/publications/rb/rb1501/rb1501.htm>; Internet; accessed 2 December 1999.

[65] Peters, 13.

[66] Pace and Wilson, 9-10.

[67] National Security Council, Office of Science and Technology Policy, "Fact Sheet - U.S. Global Positioning System," 29 March 1996; available from <http://www.whitehouse.gov/WH/EOP/OSTP/html/gps-factsheet.html>; Internet; accessed 1 January 2000.

[68] Ibid., See "Agency Roles and Responsibilities" section of the Policy.

[69] White House, Office of the Vice President, "Vice President Gore Announces New Global Positioning System Modernization Initiative," 25 January 1999; available from <http://www.pub.whitehouse.gov/uri-res/I2?urn:pdi://oma.eop.gov.us/1999/1/25/17.text.1>; Internet; accessed 28 October 1999.

[70] Ibid.

[71] Alasdair McLean, "European Exploitation of Space: when rather than if," Rusi Journal 144 (October 1999), 49.

[72] Moorman, 12.

[73] William W, Brunner III, "National Security Implications of Inexpensive Space Access," School of Advanced Airpower Studies, Air University, Maxwell AFB, AL, 1996; available from <http://www.au.af.mil/au/database/projects/ay1995/saas/brunnerww.pdf>; Internet; accessed 26 December 1999.

[74] "World Space Guide – Launch Facilities," linked from Federation of American Scientist, at "Space Policy," available from <http://www.fas.org/spp/guide/facility.htm>; Internet; accessed 3 January 2000. The countries with launch facilities are Brazil, China, French Guiana (European Space Agency's launch facilities), India, Israel, Italy, Japan, Russia and the United States. The Sea Launch Co. successfully launched its first satellite in October 1999. The Sea Launch Co. is a limited duration corporation with a homeport facility in Long Beach, CA and is owned by Boeing Commercial Space Co of Seattle, WA. (40%), RSC-Energia of Russia (25%), Kvaerner Maritime a.s. of Norway (20%), and KB Yuzhnoye/PO Yuzhmash of Ukraine (15%). Information about the Sea Launch Co. was obtained from Sea Launch home page, <http://www.boeing.com/defense-space/space/sealaunch/>; Internet; accessed 3 January 2000.

[75] "Department of the Air Force Presentation to the House Permanent Select Committee on Intelligence Subcommittee on Technical and Tactical Intelligence U.S. House of Representatives," 15 June 1999; Statement by Mr. Keith R. Hall, Assistant Secretary of the Air Force (Space) and Director, National Reconnaissance Office; available from <http://www.nro.odci.gov/speeches/15june99sfr.html>; Internet; accessed 14 January 2000.

[76] Commercial Space Launch Act. U.S. Code. Vol. 49, secs. 2601-2623 (1984).

[77] Ibid., sec. 2602.

[78] Ibid., secs. 2604 and 2619.

[79] David Brandt, "Encouraging Space Commerce," 4 March 1996; available from <http://www.nss.org/alerts/positions/positions02.html>; Internet; accessed 10 November 1999.

[80] "Commercial Space Launches and Foreign ICBM Programs."

[81] "National Space Transportation Policy, NSTC-4," 5 August 1994; available from <http://www.hq.nasa.gov/offices/codez/nstc4.html>; Internet; accessed 27 January 2000.

[82] Ibid.

[83] White House, "Fact Sheet - Clinton Administration Space Accomplishments."

[84] "Department of the Air Force Presentation to the House Permanent Select Committee on Intelligence Subcommittee on Technical and Tactical Intelligence U.S. House of Representatives."

[85] Jim Oberg, Space Power Theory (US Air Force Academy: Government Printing Office, March 1999), 49.

[86] "Does Commercial Development of Space Technology Compromise National Security Interests?" 25 March 1999; available from <http://wwics.si.edu/WHATSNEW/NEWnews/space.htm>; Internet; accessed 28 December 1999. Summary from "Space and International Relations: Challenges for the Twenty-First Century" Conference held at the Woodrow Wilson International Center for Scholars, Washington, D.C.

[87] Department of Defense, "Advanced Military Satellite Communications CAPSTONE Requirements Document," 1-15 through 1-18.

[88] Ibid., 2-1 through 2-9.

[89] Army Training and Doctrine Command, 6-2.

[90] Ibid., 6-2.

[91] John Pike, "Military Space Proliferation," Army War College, Annual Strategy Conference (Washington, D.C.; Federation of American Scientist, 28 April 1994), 23.

[92] Johnson-Freese and Handberg, 192.

[93] Pace and Wilson, 11.

[94] National Security Council, "Fact Sheet: U.S. Global Positioning System Policy."

[95] Robert A. Nelson, "The Global Positioning System: A National Resource," Phillips Business Information, Inc. 14 (10 November 1999) [database on-line]; available from Lexis-Nexis.

[96] Johnson-Freese and Handberg, 223-224.

[97] National Defense Panel, Transforming Defense: National Security in the 21st Century, (Arlington, VA: U.S. Department of Defense, December 1997.), 38.

[98] Sheila E. Windall, "Stewards of Space," 8 May 1996; Remarks delivered by the Secretary of the Air Force to the Space Transportation Association; available from <http://www.fas.org/spp/military/docops/usaf/di1150.html>; Internet; accessed 28 December 1999.

[99] William J. Clinton, "Memorandum on Assessment of Space Launch Vehicles," Weekly Compilation of Presidential Documents 35 (24 May 1999): 945 UMI ProQuest, General Periodicals Ondisc [CD-ROM], 1999, item 04330394.

[100] Larry Downes and Chunka Mui, Unleashing the Killer App, (Boston, MA.: Harvard Business School Press, 1998), 4. "App" means applications. Downes and Mui define "killer app" as "a new good or service that establishes an entirely new category and, by being first, dominates it, returning several hundred percent on initial investment." Examples of killer apps are personal computers and the first word processing program. The commercial remote sensing and navigation activities of space are definitely killer apps, establishing an entirely new service available to the commercial sector, which impacts on lives daily. Commercial satellite communications like Iridium and Teledesic are killer apps, opening up new markets, enabling individuals to communicate from almost anywhere in the world.

[101] Dana J. Johnson, Scott Page, and C. Bryan Gabbard, Space – Emerging Options for National Power (Washington, D.C.: RAND, 1998), 72.

BIBLIOGRAPHY

Ball, Jonathan, Shelly Boyd, Kimberly Skryd, and Richard Sweet. "Trends in Commercial Space 1996: Global Positioning System (GPS): Location and Navigation." Available from <http://www.ta.doc.gov/space/tics/gps.html>. Internet. Accessed 10 November 1999.

Ball, Jonathan. "Trends in Commercial Space 1996: Satellite Remote Sensing." Available from <http://www.ta.doc.gov/space/tics/rmtsens.html>. Internet. Accessed 10 November 1999.

Bettelheim, Adriel. "New Challenges in Space." CQ Researcher 9 (23 July 1999): 617 - 640. UMI ProQuest, General Periodicals Ondisc [CD-ROM], 1999, item 04391964.

Black, Todd J. "Commercial Satellites: Future Threats or Allies?" Naval War College Review 52 (Winter 1999): 99-114.

Brandt, David. "Encouraging Space Commerce." 4 March 1996. Available from http://www.nss.org/alerts/positions/position02.html. Internet. Accessed 10 November 1999.

Broad, William J. "Commercial Use of Spy Satellites to Begin; Private Ventures Hope for Profits." New York Times, 10 February 1997, sec. 1A, p.1 and sec 1B, p.7.

_____. "Private Spy in Space to Rival Military's." 27 April 1999. Available from <http://www.fas.org/eye/042799sci-spy-satelllites.htm>. Internet. Accessed 3 January 2000.

Brown, George E., Jr. "Space and International Relations: Challenges for the 21st Century." 25 March 1999. Available from <http://www.house.gov/science_democrats.speeches/wilson_space.htm>. Internet. Accessed 1 October 1999.

Brunner, William W., III. "National Security Implications of Inexpensive Space Access." School of Advanced Airpower Studies, Air University, Maxwell AFB, AL, 1996. Available from <http://www.au.af.mil/au/database/projects/ay1995/saas/brunnerww.pdf>. Internet. Accessed 26 December 1999.

Byerly, Radford, Jr., ed. Space Policy Alternatives. Boulder, CO: Westview Press, 1992.

Calhoun-Senghor, Keith. "Trends in Commercial Space." Available from <http://www.comlinks.com/satcom/tics.html>. Internet. Accessed 22 October 1999.

Clinton, William J. A National Security Strategy for a New Century. Washington, D.C.: The White House, October 1998.

_____. "Memorandum on Assessment of Space Launch Vehicles." Weekly Compilation of Presidential Documents 35 (24 May 1999): 945. UMI ProQuest, General Periodicals Ondisc [CD-ROM], 1999, item 04330394.

_____. National Space Policy. Washington, D.C.: The White House, 19 September 1996.

Cohen, William S. "Opening Ceremonies of the National Space Symposium." 5 April 1999. Available from <http://www.defenselink.mil/speeches/1999/s19990405-secdef.html>. Internet. Accessed 30 September 1999.

"Commercialization, Trade and National Security." 6 April 1999. Session remarks from the 15th National Space Symposium, Colorado Springs, CO. Available from <http://ussf.iex/net/symposium99/proceedings/trade_and_national_security.html>. Internet. Accessed 28 December 1999.

Commercial Space Launch Act. U.S. Code. Vol. 49, secs. 2601-23 (1984).

"Commercial Space Launch and Foreign ICBM Programs." Linked from Federation of American Scientists at "Space." Available from <http://www.fas.org/spp/starwars/congress/1998_h/s980521t.htm>. Internet. Accessed 3 January 2000.

Communications Satellite Act of 1962. Unites States Code Congressional and Administrative News. 87th Cong., 2nd sess., 1962. St. Paul: West Publishing Co., 1963. Vol. 1, 489-98.

DeBlois, Bruce M., LTC (USAF). "Space Sanctuary, A Viable National Strategy." Airpower Journal (Winter 1998): 41-57.

"Department of the Air Force Presentation to the House Permanent Select Committee on Intelligence Subcommittee on Technical and Tactical Intelligence U.S. House of Representatives." 15 June 1999. Statement by Mr. Keith R. Hall, Assistant Secretary of the Air Force (Space) and Director, National Reconnaissance Office. Available from <http://www.nro.odci.gov/speeches/15june99sfr.html>. Internet. Accessed 14 January 2000.

Devost, Matthew G. "National Security in the Information Age." May 1995. Available from <http://www.terrorism.com/documents/devostthesis.html>. Internet. Accessed 26 December 1999.

"Does Commercial Development of Space Technology Compromise National Security Interests?" 25 March 1999. Available from <http://wwics.si.edu/WHATSNEW/NEWnews/space.htm>. Internet. Accessed 28 December 1999. Summary from "Space and International Relations: Challenges for the Twenty-First Century" Conference held at the Woodrow Wilson International Center for Scholars, Washington, D.C.

Downes, Larry, and Chunka Mui. Unleashing the Killer App. Boston, MA.: Harvard Business School Press, 1998.

Dudney, Robert S. "The New Space Plan." Air Force Magazine, July 1998, 22-24.

Estes, Howell M., III, Gen (USAF). "Sustaining the Strategic Space Advantage." 13 March 1997. Available from <http://www.house.gov/science_democrats.speeches/wilson_space.htm>. Internet. Accessed 1 October 1999.

Fisher, Richard D. "Commercial Space Cooperation Should Not Harm National Security." 26 June 1998. Linked from The Heritage Foundation at "Backgrounder." Available from <http://www.heritage.org/library/background/bg1198.html>. Internet. Accessed 10 November 1999.

Hughes, Patrick M., LTG (USA). "Global Threats and Challenges: The Decades Ahead." 2 February 1999. Linked from American Forces Information Service – Defense Viewpoint. Available from <http://www.defenselink.mil/cgi-bin/dlprint>. Internet. Accessed 30 September 1999.

Johnson, Bryan T. "The New Space Race: Challenges for U.S. National Security and Free Enterprise." Linked from The Heritage Foundation at "Backgrounder." Available from <http://www.heritage.org/library/backgrounder/bg1316es.html>. Internet. Accessed 7 October 1999.

Johnson, Dana J., Scott Page, and C. Bryan Gabbard. Space – Emerging Options for National Power. Washington, D.C.: RAND, 1998.

Johnson-Freese, Joan, and Roger Handberg. Space, The Dormant Frontier: Changing the Paradigm for the 21st Century. Westport, CT: Praeger, 1997.

Kaminski, Paul G. "'Outside-the-Box' Thinking Needed." 11 February 1997. Available from <http://www.defenselink.mil/speeches/1997/s19970211-kaminski.html>. Internet. Accessed 1 October 1999. Keynote address of the Under Secretary of Defense for Acquisition and Technology to the 2nd Annual Space Policy and Architecture Symposium

Klinger, Gil I. "Military Space Activities: The Next Decade." Aerospace America, January 1998, 44-51.

Klotz, Frank G. Space, Commerce, and National Security. New York: Council on Foreign Relations Press, 1998.

Land Remote Sensing Act of 1992. Unites States Code Congressional and Administrative News. 102nd Cong., 2nd sess., 1992. St. Paul: West Publishing Co., 1993. Vol. 3, 4163-4180.

Mann, Paul. "Lawmakers Clobber Satellite Exports." Aviation Week & Space Technology 150 (28 June 1999): 30-32.

McKenna, James T. "USAF to Ease Access for Space Business." Aviation Week & Space Technology 142 (27 February 1995): 56-57.

McLean, Alasdair. "European Exploitation of Space: when rather than if." Rusi Journal 144 (October 1999): 47-50.

Moorman, Thomas S., Jr., GEN (USAF/Ret). "The Explosion of Commercial Space and the Implications for National Security." Airpower Journal (Spring 1999): 6-20.

Myers, Richard B., GEN (USAF). "Implementing our Vision for Space Control." 7 April 1999. Available from <http://www.spacecom.af.mil/usspace/speech15.htm>. Internet. Accessed 16 December 1999.

National Aeronautics and Space Act of 1958. Unites States Code Congressional and Administrative News. 85th Cong., 2nd sess., 1958. St. Paul: West Publishing Co., 1959. Vol. 1, 502-517.

National Defense Panel. Transforming Defense: National Security in the 21st Century. Arlington, VA: U.S. Department of Defense, December 1997.

National Security Council, Office of Science and Technology Policy. "Fact Sheet - U.S. Global Positioning System." 29 March 1996. Available from <http://www.whitehouse.gov/WH/EOP/OSTP/html/gps-factsheet.html>. Internet. Accessed 1 January 2000.

"The National Space Council – Putting Space Back on the Political Agenda." Available from <http://ussf.iex.net/symposium99/proceedings/national_space_council.html>. Internet. Accessed 14 February 2000.

"National Space Transportation Policy, NSTC-4." 5 August 1994. Available from <http://www.hq.nasa.gov/offices/codez/nstc4.html>. Internet. Accessed 27 January 2000.

Nelson, Robert A. "The Global Positioning System: A National Resource." Phillips Business Information Inc. 14 (10 November 1999). Database-on-line. Available from Lexis-Nexis.

"1999 – The Year in Review: The Highs and Lows of a Year in Space." Space News, 13 December 1999, 14.

Oberg, Jim. Space Power Theory. US Air Force Academy, Colorado Springs, CO.: March 1999.

Pace, Scott, "Promoting Commercial Space Activity." 31 July 1996. Prepared statement for the record of Scott Pace, Ph.D., The Rand Corporation, before the U. S. House of Representatives Subcommittee on Space and Aeronautics. Available from <http://www.house.gov/ science/scott_pace.htm>. Internet. Accessed 28 December 1999.

_____, and James E. Wilson. Global Positioning System – Market Projections and Trends in the Newest Global Information Utility. Santa Monica, CA.: RAND Corporation, 1998.

_____, Gerald Frost, Irving Lachow, David Frelinger, Donna Fossum, Donald K. Wassem, and Monica Pinto. The Global Positioning System – Assessing National Policies. Santa Monica, CA.: RAND Corporation, 1995.

Peters, Katherine McIntire. "Space Wars." Government Executive 30 (April 1998): 12-20.

Pike, John. "Export Controls Relating to Commercial Communications Satellites." 16 June 1998. Prepared statement by the Director, Space Policy Project, Federation of American Scientists, before the U. S. House of Representatives House Rules Committee. Available from <http://www.fas.org/spp/starwars/congress/1998_h/h980616-pike.htm>. Internet. Accessed 1 January 2000.

_____. "Military Space Proliferation." Army War College, Annual Strategy Conference. Washington, D.C.: Federation of American Scientists, 28 April 1994.

"A Policy Direction for the Global Positioning System: Balancing National Security and Commercial Interests." Available from <http://www.rand.org/publications/rb/rb1501/rb1501.htm>. Internet. Accessed 2 December 1999.

"Presidential Directive on National Space Policy- A Fact Sheet." 11 February 1988. Available from <http://www.hq.nasa.gov/office/pao/History/policy88.html>. Internet. Accessed 10 January 2000.

"Presidential Review Directive/NSTC-2." 15 May 1995. Available from <http://www.hq.nasa.gov/office/codez/history/f2.htm>. Internet. Accessed 22 January 2000.

Scott, William B. "Space Chief Warns of Threats to U.S. Commercial Satellites." Aviation Week & Space Technology 150 (21 April 1999): 51.

Silverstein, Sam. "Satellite Industry Wrestles with Financing, U.S. Laws." Space News, 13 December 1999, 20.

"Space Commercialization: An AIAA Position Paper Prepared by the Public Policy Committee." Available from <http://www.aiaa.org/cgi-bin/wg2?WAISdocID=783017188+9+0+0&WAISaction=retrieve>. Internet. Accessed 10 November 1999.

"Space Transportation and the Global Space Commerce Market." 28 October 1998. Available from <http://www.futron.com/AIAAFNL2.pdf>. Internet. Accessed 4 December 1999.

Stares, Paul B. Space and National Security. Washington, D.C.: The Brookings Institute, 1987.

"State of the Space Industry – 1999." Available from <http://www.gn.apc.org/acp/space/state-of-space.html>. Internet. Accessed 16 February 2000.

U.S. Army Training and Doctrine Command. 1998-1999 - The Army Satellite Communications Architecture Book. Reston, VA; ITAC, December 1998.

U.S. Department of Defense. Advanced Military Satellite Communications CAPSTONE Requirements Document. Colorado Springs, CO.: U.S. Space Command, 24 April 1998.

_____. Defense Department Space Policy. Washington, D.C.: U.S. Department of Defense, 9 July 1999.

_____. Space Program – An Executive Overview for FY 1998-2003. Washington, D.C.: U.S. Department of Defense, March 1997.

Van Tuyll, Hubert P. America's Strategic Future: A Blueprint for National Survival in the New Millennium. Westport, CT: Greenwood Press, 1998.

Whalen, David J. "Communications Satellites: Making the Global Village Possible." Available from <http://www.hq.nasa.gov/office/pao/History/satcomhistory.html>. Internet. Accessed 10 January 2000.

White House, Office of the National Science and Technology Council. "Fact Sheet – National Space Policy." 19 September 1996. Available from <http://www.fas.org/spp/military/docops/national/nstc-8.htm>. Internet. Accessed 10 September 1999.

White House, Office of the President of the United States. "Executive Order 12046 – Relating to the transfer of telecommunications functions." 27 March 1978. Available from <http://www.nara.gov/fedreg/eos/e12046.html>. Internet. Accessed 11 January 2000.

White House, Office of the President of the United States. "Executive Order 12675 – Establishing the National Space Council." 20 April 1989. Available from <http://envirotext.eh.doe.gov/data/eos/bush/19890420.html>. Internet. Accessed 22 January 2000.

White House, Office of the Press Secretary. "Fact Sheet – Clinton Administration Space Accomplishments." 30 October 1998. Available from <http://www.reston.com/nasa/white.house/10.30.98.accomplishments.html>. Internet. Accessed 28 December 1999.

White House, Office of the Press Secretary. "Foreign Access to Remote Sensing Space Capabilities – Fact Sheet." 10 March 1994. Available from <http://www.whitehouse.gov/wh94imagery.htm >. Internet. Accessed 12 October 1999.

White House, Office of the Vice President. "Vice President Gore Announces New Global Positioning System Modernization Initiative." 25 January 1999. Available from <http://www.pub.whitehouse.gov/uri-res/I2?urn:pdi://oma.eop.gov.us/1999/1/25/17.text.1>. Internet. Accessed 28 October 1999.

"Who We Are." Linked from National Reconnaissance Office at "Background." Available from <http://www.nro.odci.gov/background.html>. Internet. Accessed 10 January 2000.

Windall, Sheila E. "Stewards of Space." 8 May 1996. Remarks delivered by the Secretary of the Air Force to the Space Transportation Association. Available from <http://www.fas.org/spp/military/docops/usaf/di1150.html>. Internet. Accessed 28 December 1999.

"World Space Guide – Launch Facilities." Linked from Federation of American Scientists at "Space Policy." Available from <http://www.fas.org/spp/guide/facility.htm>. Internet. Accessed 3 January 2000.